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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: **WESLEY WILKINSON**

Serial No.: 08/945,017 Group Art Unit: 3611

Filed: OCTOBER 27, 1997 Examiner: C. BOTTORFF

Title: CONTROL WHEEL ASSEMBLY FOR TROLLEYS

SUPPLEMENTAL DECLARATION UNDER 37 C.F.R. §1.132

Commissioner for Patents
Washington, D.C. 20231

Sir:

I, Wesley WILKINSON, hereby declare that:

1. I am a citizen of Australia, residing at 28 Bemboka Avenue, Clayton South, Victoria, Australia 3169.

2. I am the sole inventor of the above-identified U.S. patent application and make this Declaration in support of said patent application.

3. **ORIGIN OF THE CLAIMED TROLLEY**

The claimed trolleys were developed as a result of Work Systems Technology, of which I am the principal, addressing manual handling concerns at the Beleura Private Hospital in Victoria Australia. The hospital was experiencing a number of debilitating manual handling injuries associated with the food service department of the hospital. The injuries were directly related to the use of heavy, conventional four castor meal trolleys used by the staff to deliver meals throughout the hospital. The workers experienced neck, shoulder, and back soft tissue injuries that prevented them from carrying out their duties. I was engaged to carry out an evaluation of the situation and recommend corrective actions.

The range of different types of food service trolleys available on the market was investigated with little success. None of the available products on the market were designed to meet OHS statutory legislation for Manual Handling. The available units that incorporated steering chassis had front or rear fixed wheels with the inherent mechanical deficiencies of non co-incident geometric and load centers,

thereby creating excessive steering forces which I reported in Wilkinson, "Integrating Human Factors and Engineering Concepts into Trolley Design". It was therefore determined that, since no suitable chassis was commercially available, experimentation with chassis design should be undertaken.

The appreciation that a control wheel must follow the ground was established and swing arm mechanisms were experimented with, such as that disclosed in Lloyd. With reference to the following theory on traction forces and wheel dynamics, it became clear to me that springs could not provide the correct characteristic. Due to the complexity of the dynamic requirements of the mechanism, it then took some time (2-3 months) to identify that a particular type of gas strut provided the required characteristic.

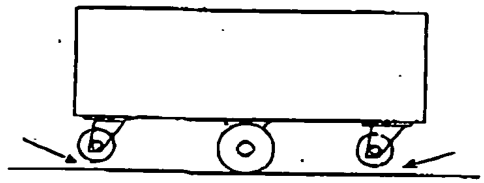
4. ANALYSIS OF TROLLEYS IN THE MARKETPLACE NOT HAVING A FIFTH CONTROL WHEEL

Applied mechanics analysis of forces in trolley chassis concluded that a resultant steering point that coincides with the center of mass of the loaded/unloaded trolley was needed in order to eliminate excessive operating forces that make control of the direction of the trolley physically difficult for the user. A resultant steering reaction point is the point at which the trolley effectively steers about (the pivot point).

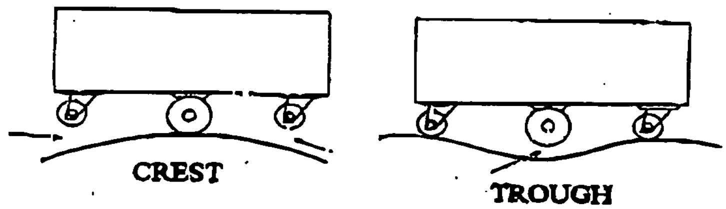
For a trolley with all castors, the operators spine/feet would provide the steering reaction point. Moving the trolley requires a pushing force in the desired direction and a constant restraining force applied about the feet requiring a twisting reaction about the spine to successfully control the direction of the trolley. The restraining/change of direction force is the part that the trolley user finds most difficult.

The problem is typified by the behaviour of the standard supermarket trolley or cart with it's four castor configuration.

The only available chassis configuration in the market place that addressed the problem was that of the market trolley with its center axle and large wheels on either side of the trolley with two castors on each end of the trolley. This configuration has disadvantages due to the rocking characteristic created by supporting the load with the large center wheels while the castors are effectively off the ground.



Market Trolley Configuration



Market Trolley Configuration difficulty with terrain

The market configuration has other deficiencies, when dealing with ramps and dips in the normal terrain encountered in the work environment (as shown above). On the crest of a ramp, the center wheels support the trolley with a large gap between one set of castors and the ground. The load on the trolley may shift and fall onto the user or onto the ground.

When a dip is encountered the weight of the trolley is supported on the four castors leaving the large center wheels clear of the ground. The trolley then has no effective steering reaction point and becomes uncontrollable.

Of the available trolleys in the marketplace, none had a fifth wheel design.

5. REQUIREMENTS OF A FIFTH CONTROL WHEEL

Having carried out the analysis of trolley chassis dynamics from engineering principles, I established the need for a steering reaction point located at a point in the chassis that was co-incident with the geometric and load center of the trolley. In other words the chassis must be designed to have the load center of mass (unloaded and loaded) and the geometric center coincident. This has been referred to as a "fifth wheel system".

The required fifth wheel system must have particular attributes to allow it to perform properly dynamically. These attributes include:

A UPWARDS AND DOWNWARDS VERTICAL.MOVEMENT FOR UNDULATING TERRAIN

The fifth wheel must be in contact with the ground over a range of travel consistent with the terrain in which the trolley is to be used. The control wheel should be allowed to move in a vertical direction to deal with normal ramps and dips experienced in workplaces and public places. With the horizontal surface as the reference, the wheel must travel in an upwards and downwards direction relative to the horizontal.

As I discussed at the August 2, 2000 interview., Lloyd must not have built his design since he only considered the upward travel and therefore his design would not have worked when the trolley encountered a trough. The fifth wheel of Lloyd could not follow the contact surface if it passed below the horizontal reference. Lloyd appears to have been hypothetical and theoretical without actual proto-typing and testing.

B. SUFFICIENT FORCE TO PROVIDE LATERAL TRACTION

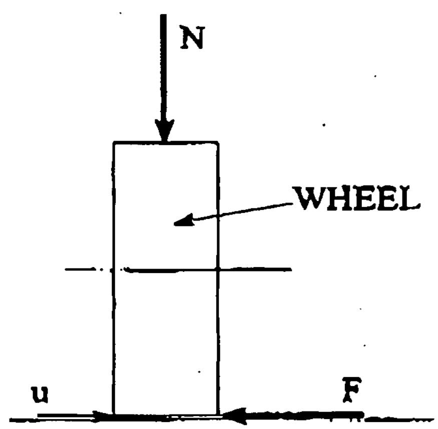
At any point in the vertical travel, the control wheel must have sufficient contact force with the ground to provide the necessary lateral traction to prevent the wheel from skidding and to allow the steering reaction point to function, loaded or unloaded. The control wheel is required to be in traction with the ground without drift in order to eliminate the requirement for the operator to provide a restraining force, especially on a slope. To be in traction with the ground, consideration of the friction equation is required:

F=uN,

where F = force (e.g., trolley mass wanting to move sideways down a grade);

u = coefficient of friction of wheel/tire on floor surface; and

N = force in direction normal to that of movement (i.e., downforce).



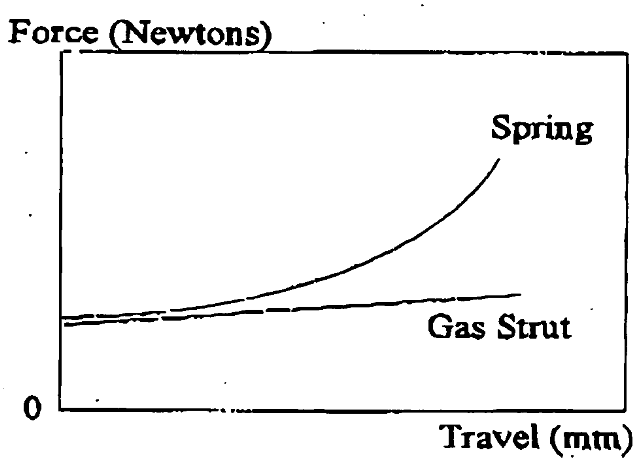
Friction Relationship

F dramatically increases on lateral slopes, while the normal force N stays constant due to the component of the mass of the trolley acting down the slope increasing F.

To prevent slippage uN must exceed any force F experienced in normal use of the trolley. The typical sideways slope of the supermarket parking lot is the classic example of the terrain where the correct normal force is critical for satisfactory performance, both loaded and unloaded.

C. RELATIVELY CONSTANT FORCE OVER VERTICAL TRAVEL

The force N must also not exceed the force which would lift the unladen trolley off the ground. The force N must also not be exceeded throughout the control wheel's vertical travel. Otherwise, the unladen trolley cannot traverse humps or crests since the control wheel would not be able to move vertically relative to the trolley if N is relatively too large. Because force N is critical, it must be maximised at the point just before the unladen trolley lifts off the ground. This requirement implies that the force is relatively constant over the vertical travel, something that is **not** achievable with mechanical springs where the force increases proportionally to travel in a non-linear relationship. The following graph was drawn on the whiteboard during the August 2, 2000 interview:



The transparent gas strut that I demonstrated at the interview showed the components and method of operation of the strut. It could be clearly seen that the strut comprised a pressurised chamber containing a piston and rod which passes through a seal and out of one end of the chamber. It was also able to be seen that there was no other means of providing resilience in the chamber other than the gas (i.e., there were no mechanical springs). A valving hole through the piston allows

equalization of pressure on either side of the piston during compression of the strut. The rest position of the gas is the extended position. The force provided by the constant gas pressure in the chamber over the larger area of the piston on the non-rod side is greater than that on the rod side since the rod effectively reduces the piston surface area. The reduction in cylinder volume caused by the cylinder rod during compression causes the small rise in pressure and therefore force over the travel of the piston. Movement of the piston is counteracted by the force imbalance which returns the piston to the extended position. Damping is achieved by seal friction during travel and oil at the extremes of travel.

6. REQUIRED FORCES ARE SATISFIED BY A GAS STRUT

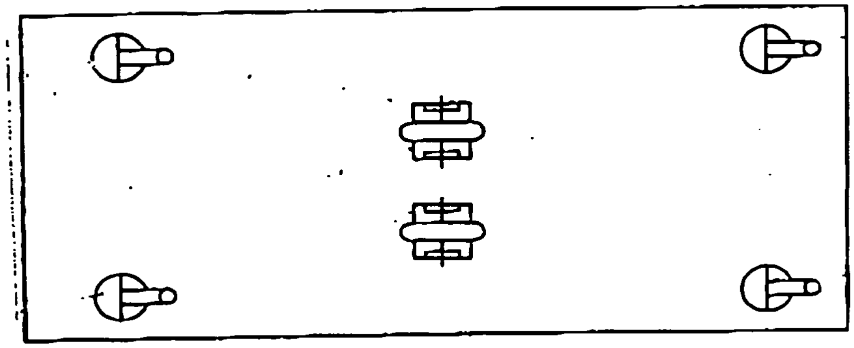
The normal force N is provided by a gas strut in the claimed trolley design for a number of reasons:

A. The gas strut provides a near linear force relationship. See Stabilus manual. As noted above, coil springs cannot provide the required constant force range throughout the entire range of required travel. At the August 2, 2000 interview, I demonstrated a gas strut's almost linear force range on an analogue bathroom scale in comparison to a unit with a spring of equivalent force at the appropriate free length. When compressed, the spring quickly exceeded the force maximum required to use the unladen trolley without lifting it of the ground. At full travel, the spring provided a force double that required. This would of course lift the unladen trolley off the ground.

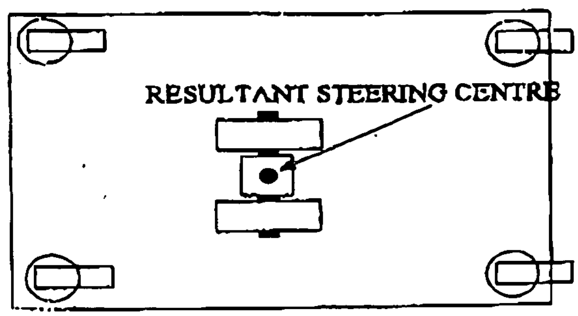
B. The force N must also provide sufficient force to retain control wheel traction of the loaded trolley on a lateral grade. The design of the gas strut provides the normal force N and integral damping to control the extension direction of the travel while preventing control wheel bounce.

C. The gas strut also provides a compact convenient means of providing the desired dynamic characteristics for the control wheel mechanism. The gas strut simplifies mechanism and eliminates parts. Further, the force N can be specified exactly to meet trolley requirements (not able to be easily achieved with mechanical springs).

D. Dual pairs of gas struts and wheels may used on heavy load trolleys to assist lateral traction:



E. Dual wheels and one gas strut may also be used to gain additional traction.



Four castor trolley with one column (strut) and dual wheels

7. COMMERCIAL SUCCESS

Over the course of the past few years some 600 trolleys have been sold into known manual handling problem workplace situations. Some 450 of these trolleys are Ergo-Sled® Coin Trolleys sold to the Commonwealth Bank of Australia (CBA) specifically to address the manual handling injury experience of handling coin within the banks. The attached 1.132 Declaration of Ms. Bray shows that the claimed trolleys having a gas strut have displaced the previously-used trolleys for the CBA. Since the introduction of the trolleys, the injury experience has diminished to almost zero with the CBA being ecstatic about the risk management performance of the trolleys. There have been no known manual handling injuries resulting from the other units sold to date.

The success of the fifth wheel design in reducing operating forces and improving handling dynamics can be directly attributed to the incorporation of the gas strut since it provides the correct control wheel characteristic specifically matched to the trolley application.

8. SUMMARY

The claimed trolley design addresses all of the dynamic requirements for a control wheel to work effectively over the types of surfaces expected in workplaces and public places. It is not comparable with Lloyd since Lloyd uses swing arm designs as a basis to address the issue of lateral movement. The claimed trolley design addresses the dynamic performance issues significantly better than any other prior art mechanism under the fifth wheel or control wheel concept, due to the research and development work carried out to determine the required characteristics and develop the gas strut control wheel column.

The claimed trolley design has:

a. a minimum number of components compared to all other control wheel designs;

b. is specifically tuned to the particular trolley requirements via specification of column travel and the force characteristic of the gas strut;

c. functions correctly whether the trolley is loaded or unloaded;

d. copes with ramps, crests, and dips (Lloyd does not consider dips and is indicative that it has not been tried on undulating surfaces);

e. is superior in dynamic performance to all other designs;

f. is economical to fit to trolleys during manufacture;

g. is commercially viable as part of a trolley design concept aimed at minimisation of operating forces; and

h. combined with the other design features of Wilkinson's trolleys, there is an extensive and proven injury prevention history resulting from the superior engineering and ergonomic design features.

Serial No. 09/113,547

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: 25 JANUARY 2001

WESLEY WILKINSON